Comments on Suitability of Variable Servicer Analog Display Routine for Manned LM Flights

References: (a) MSC FA40, "Latest in Luminary for Apollo 14," dated 24 July 1970, received 29 July 1970.

(b) Revision 31 of AGC Program Zerlina, dated 16 July 1970, received 24 July 1970.

Reference (a) indicates that MSC plans to incorporate the landing analog display routine of reference (b) into the LM program for the manned Apollo 14 flight. A review of the coding in reference (b) reveals that the following penalties will have to be paid for this MSC decision (when evaluated against the performance of the Luminary 173 program):

1) Luminary 173 (and the Apollo 13 program) had anomaly L-1B-04 fixed, while reference (b) does not. Hence if RR error counters should be disabled, then no automatic enabling of them is done (a check of bit 2 of channel 12 is needed). Although the anomaly report is not available, reference to Luminary memo #121 indicates that one way for error counter enable to be reset is "when the RR is cycled on and off."

2) Luminary 173 computed information for R1 of N60 (forward velocity) regardless of the position of the switch on the spacecraft panel controlling display of data on the meters. This change, "authorized" by ACB L-11 (it impacted Section 2 and Section 4 GSOPs), is not in reference (b). Consequently, the warning note on page 1-7 and 1-49 of the Apollo 14 Flight Crew G&N Dictionary (15 June 1970) that proper R1 data "requires MODE SEL - PGNS" for N60 must be retained, whereas its deletion was possible if Luminary 173 had been used.

3) Luminary 173 allowed the maximum display on the crosspointers (at least as fed to the error counters) be about 200 fps, in accordance with the information on the required range given on page 5.3-118 of the Section 5 Rev. 8 Approved by NASA GSOP. Reference (b), however, contains a constant which seems to limit the maximum display to only about half this number (the quantity MAXVEL, line 0140 on page 43, has a value of 00233_8 which seems to be about $99.32 \times 0.3048 \times 0.01 \times 2^{-5}$, where first term is fps, 2nd converts to meters, 3rd to centi-seconds, and fourth is scale factor). The program comments indicate a scale factor of "B6", which has not been successfully supported by the computations on pages 884-5, which seem to make use of a quantity scaled B5 instead.

4) Although Luminary 173 made use of single precision computations, it provided them with a consistent sign. Page 884 of the listing, however, computes forward velocity information as:

$$\text{FORVTEMP} = \text{M32 VHZ}_{dp} - \text{M22 VHY}_{sp} + \text{M22 VHY+1}_{sp}$$

It appears that the last term has the wrong sign, thus raising the question, in view of presumably successful tests, of whether it needs to be included at all. Its omission would save a small amount of execution time.

5) An apparently influencing factor in reference (a) was that the program "begin displaying analog data at TIG - 30 seconds" (item (d) on page 1). Since Average-G state vector initialization is for TIG - 29.9 seconds, however, the first display (setting of a flagbit) would not be expected to be initiated until some time after TIG - 27.9 seconds, not "TIG - 30" as specified by MSC.

Given on the following pages is some information on the equations in reference (b), in the event this material may have some relationship to what is put in the manned LM Apollo 14 program.

Comments on Rev. 31 of LM Variable Servicer Program

Reference: Revision 31 of AGC Program Zerlina, dated 16 July 1970, received from MSC 24 July 1970.

The following questionable items have been identified as a result of a brief one-pass scan of the reference.

Page	Comment
142	LRWH1 is assigned to E7,1742, the same cell as used for VEX in P40. Hence P40 cannot be used prior to P64 without manually loading LRWH1 again. This lockout is in direct conflict with the mission sequence ("nominal") shown on page 5.1-14 of Section 5 Rev. 8 Luminary GSOP (approved by NASA), which shows P40 being performed prior to the landing programs. Although such a performance is not necessarily indicative of MSC flight plans, explicit MSC approval to delete the capability (especially when the four landing radar antenna angles are still filling up memory, though unreferenced) must be obtained. As described in anomaly L-1D-08, the Luminary 173 location for this quantity is also unsatisfactory. Other areas of the program reflect the "technology level" of Luminary 173 also (and its anomalies). E7,1742 also used for P20's RRBORSIT (most sig. half of Y component).
567	The cells loaded for telemetry in "R12DL" do not satisfy the requirements of the Section 2 Rev. 9 GSOP (approved by NASA), which requires that the time tag and CDU angle information be for the LR sample (of e.g. velocity or range), rather than be the quantities sampled at accelerometer read time. The quantities telemetered are appropriate for the Luminary 173 design; for the reference, information provided should be that read by "RDGIMS" instead (as in earlier LM programs).
815	The Section 2 Rev. 9 GSOP (approved by NASA) specifies that FLGWRD11 be set to 40000_8 by R11 "when an abort is requested". This page, at the cost of an additional program step, merely sets bit 15, leaving other bits at their previous value.
847	The setting of 1/PIPADT to PGUIDE presumably should be to PGUIDE1 instead (in order to reflect the most recent time delay since entrance to "1/PIPA", as well as to have a proper value on the first pass).
879	The Luminary 173 performance "authorized" by ACB L-11, allowing R1 of N60 to be updated even if panel switch not set to cause display, should be reflected in the reference also. The design change since Apollo 13 should have been a PCR, of course, in view of the impact on bit 14 of FLAGWRD1 in Section 2 GSOP, and on R10 in Section 4 GSOP.
947	The revised scaling of 1/PIPADT (from B8 to B10 centi-seconds) does not seem reflected in the initialization of the cell in "LUNG" for P57 purposes. The old B8 scaling is also reflected on page 339, but the setting there is presumably not functional. The P57 use, of course, is not exactly two seconds anyhow.
Var.	The decision as to whether the old "two second" cycle should be retained in constants or modified should be part of the MSC design review, since a "hard-wired" two seconds still seems reflected in the V57 update rate, the "S40.8" time-to-go computation, and the computations in the ascent equations (see pages 5.3-35, 5.3-144, and 5.3-148 of Section 5 Rev. 8 GSOP).